Printed Pages:02 **Sub Code: RME403**
Paper Id: 140268 **Roll No.**

B. TECH.
(SEM IV) THEORY EXAMINATION 2018-19
APPLIED THERMODYNAMICS

Time: 3 Hours *Total Marks: 70*

Note: Attempt all Sections. If required any missing data, then choose suitably.

SECTION A

1. Attempt all questions in brief. **2 x 7 = 14**

a. What do you mean by air standard cycles? Discuss its' significance.
b. Define the following:
Brake power, Indicated power, Brake mean effective pressure, and Indicated mean effective pressure.
c. Enlist the requirements of a good boiler?
d. What do you mean by supersaturated flow?
e. Give limitations of Carnot vapour power cycle and explain how Rankine cycle helps in overcoming them.
f. Differentiate between impulse and reaction steam turbines.
g. Explain the significance of choked flow in a nozzle.

SECTION B

2. Attempt any *three* of the following: **7 x 3 = 21**

a. Derive an expression for air standard efficiency of Otto cycle in terms of compression ratio.
b. A steam engine working on Rankine cycle operates between 1.96 MPa, 250ºC and 13.7 kPa. If engine consumes steam at the rate of 0.086 kg per second, determine Rankine cycle efficiency, neglecting pump work. Also, find Rankine cycle efficiency considering pump work.
c. A boiler generates 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar from feed water having a temperature of 70 ºC. The efficiency of boiler is 75%and factor of evaporation 1.15.Specific heat of superheated steam at constant pressure is 2.3. Calculate:
(i) Degree of superheat and temperature of steam generated
(ii) Calorific value of coal in kJ/kg
(iii) Equivalent evaporation in kg of steam per kg of coal
d. In a Parson turbine running at 1500 r.p.m., the available enthalpy drop for an expansion is 65 kJ/kg. If the mean diameter of the rotor is 100cm, find the number of rows of moving blades. Assume stage efficiency = 80%, speed ratio = 0.7, and blade outlet angle = 20º.
e. A turbo jet engine consumes air at the rate of 60.2 kg/sec when flying at a speed of 1000 km/hr Calculate, (a) the exit velocity of jet when the enthalpy change in the nozzle is 230 kJ/kg and velocity coefficient is 0.96, (b) fuel flow rate in kg/sec when air fuel ratio is 70:1, (c) thrust specific fuel consumption, (d) propulsive power, (e) propulsive efficiency, and (f) the overall efficiency.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a) Explain Morse test in detail.

(b) Determine thermal efficiency and mean effective pressure of thermodynamic cycle used by a 4-strokepetrol engine. Details of cycle are as follows.
Compression ratio = 7
Initial state = 100 kPa and 90ºC
Swept volume = 0.1 m^3
Heat added to cycle at constant volume = 100 kJ/cycle.
Consider air as working fluid.

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) Describe pass out turbines and back pressure turbines

(b) A binary vapour power cycle works on mercury and steam such that dry saturated mercury vapour at4.5 bar is supplied to mercury turbine and leaves at 0.04 bar. Steam is generated as dry saturated at 15 bar and supplied to steam turbine for being expanded upto condenser pressure of 0.04 bar. Determine thermal efficiency of cycle.
For mercury take,
h_f at 4.5 bar = 62.93 kJ/kg, $h_g$at 4.5 bar = 355.98 kJ/kg,
v_f at 0.04 bar = 0.0000765 m3/kg
h_f at 0.04 bar = 29.98 kJ/kg, h_g at 0.04 bar = 329.85 kJ/kg
$s_g$at 4.5 bar = 0.5397 kJ/kg.K, $s_g$at 0.04 bar = 0.6925 kJ/kg.K,
s_f at 0.04 bar = 0.0808 kJ/kg.K

5. Attempt any *one* part of the following: 7 x 1 = 7

(a) Explain the working of water level indicator, safety valves, and fusible plug, feed check valve, pressure gauge, stop valve and blow off cock.

(b) Discuss the causes of air leakage and its effect on condenser.

6. Attempt any *one* part of the following: 7 x 1 = 7

(a) A convergent divergent nozzle expands air at 6.89 bar and 427 ^{0}C into a space at 1 bar. The throat area is 650mm ^{2} and exit area is 975mm ^{2}. The exit velocity is found to be 680 m/s when the inlet velocity is negligible. Assuming negligible friction. Calculate
a) Mass flow through the nozzle.
b) Nozzle efficiency and coefficient of velocity.

(b) What do you understand by compounding of steam turbines? Describe different types of compounding of steam turbines with appropriate diagram.

7. Attempt any *one* part of the following: 7 x 1 = 7

(a) A turbojet power plant uses aviation kerosene having calorific value of 43 MJ/kg. The fuel consumption is 0.18 kg per hr per unit thrust, when thrust is 9 kN. The aircraft velocity is 500 m/s the mass of air passing through the compressor is 27 kg/s. Calculate the air fuel ratio and overall efficiency.

(b) Consider an ideal gas turbine cycle with two stages of compression and two stages of expansion. The pressure ratio for each compressor and turbine is 3.The air enters each stage of compressor at 300K and each stage of turbine at 1200K. Determine the back work ratio and thermal efficiency of cycle assuming a) no regenerator b) regenerator with 75% effectiveness.